Toward Standardized Monitoring of Patients With Chronic Diseases in Primary Care Using Electronic Medical Records: Systematic Review

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Abstract: BACKGROUND Long-term care for patients with chronic diseases poses a huge challenge in primary care. In particular, there is a deficit regarding monitoring and structured follow-up. Appropriate electronic medical records (EMRs) could help improving this but, so far, there are no evidence-based specifications concerning the indicators that should be monitored at regular intervals. OBJECTIVE The aim was to identify and collect a set of evidence-based indicators that could be used for monitoring chronic conditions at regular intervals in primary care using EMRs. METHODS We searched MEDLINE (Ovid), Embase (Elsevier), the Cochrane Library (Wiley), the reference lists of included studies and relevant reviews, and the content of clinical guidelines. We included primary studies and guidelines reporting about indicators that allow for the assessment of care and help monitor the status and process of disease for five chronic conditions, including type 2 diabetes mellitus, asthma, arterial hypertension, chronic heart failure, and osteoarthritis. RESULTS The use of the term ”monitoring” in terms of disease management and long-term care for patients with chronic diseases is not widely used in the literature. Nevertheless, we identified a substantial number of disease-specific indicators that can be used for routine monitoring of chronic diseases in primary care by means of EMRs. CONCLUSIONS To our knowledge, this is the first systematic review summarizing the existing scientific evidence on the standardized long-term monitoring of chronic diseases using EMRs. In a second step, our extensive set of indicators will serve as a generic template for evaluating their usability by means of an adapted Delphi procedure. In a third step, the indicators will be summarized into a user-friendly EMR layout.

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Review

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Abstract

Background: Long-term care for patients with chronic diseases poses a huge challenge in primary care. In particular, there is a deficit regarding monitoring and structured follow-up. Appropriate electronic medical records (EMRs) could help improving this but, so far, there are no evidence-based specifications concerning the indicators that should be monitored at regular intervals.

Objective: The aim was to identify and collect a set of evidence-based indicators that could be used for monitoring chronic conditions at regular intervals in primary care using EMRs.

Methods: We searched MEDLINE (Ovid), Embase (Elsevier), the Cochrane Library (Wiley), the reference lists of included studies and relevant reviews, and the content of clinical guidelines. We included primary studies and guidelines reporting about indicators that allow for the assessment of care and help monitor the status and process of disease for five chronic conditions, including type 2 diabetes mellitus, asthma, arterial hypertension, chronic heart failure, and osteoarthritis.

Results: The use of the term "monitoring" in terms of disease management and long-term care for patients with chronic diseases is not widely used in the literature. Nevertheless, we identified a substantial number of disease-specific indicators that can be used for routine monitoring of chronic diseases in primary care by means of EMRs.

Conclusions: To our knowledge, this is the first systematic review summarizing the existing scientific evidence on the standardized long-term monitoring of chronic diseases using EMRs. In a second step, our extensive set of indicators will serve as a generic template for evaluating their usability by means of an adapted Delphi procedure. In a third step, the indicators will be summarized into a user-friendly EMR layout.

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KEYWORDS

monitoring of chronic diseases; indicators; primary care; systematic review; electronic medical record; diabetes mellitus type 2; arterial hypertension; asthma; osteoarthritis; chronic heart failure

Introduction

In 2016, the World Health Organization estimated that 71% of the overall deaths worldwide occurred due to noncommunicable diseases [1]. The majority of these diseases include cardiovascular diseases, chronic respiratory diseases, and diabetes. In particular, the prevalence of type 2 (non-insulin-dependent) diabetes mellitus, arterial hypertension, asthma, chronic heart failure, and musculoskeletal diseases is increasing rapidly around the world leading to increased multimorbidity and polypharmacy, especially in the older population [1,2]. The burden of these diseases consequently imposes a significant threat to health, quality of life, and economic status in the affected population. Moreover, the regular monitoring of chronic diseases poses huge challenges and requires knowledge and communication skills, as well as the

capability of organization and coordination. The chronic care model (CCM) was originally introduced to graphically picture the concept of disease management [3]. The eHealth enhanced chronic care model was subsequently introduced as the means to improve the CCM in view of the progress and development of information and communication technology [4]. This model shows the existing variety of technically well-advanced applications as part of the monitoring process. Too many clinical offices in Switzerland lack basic electronic devices since many general practitioners still use paper-based patient records.

In 2012, 31 European countries were ranked based on the usage of electronic medical records (EMRs) in primary care [5]. In this global ranking of EMR usage, Switzerland ranked number 24. In a Swiss study, only up to 44.8% of the participating primary care physicians reported the usage of EMRs [6]. Therefore, it is currently almost impossible to exchange data with digital applications that are increasingly available and used by patients [6]. To efficiently monitor patients with chronic diseases, a well-structured and organized EMR system is crucial to ensure that all necessary information can be easily entered and retrieved, while no essential information is missed. Surprisingly, there are no evidence-based specifications concerning the indicators that should be monitored at regular intervals. On one hand, there are currently no international standards for the monitoring of patients with chronic diseases by means of EMR in primary care. On the other hand, there are deficits regarding the actual monitoring and structured follow-up. Therefore, we aimed to identify and collect a set of evidence-based indicators that could be used for monitoring patients with chronic conditions at regular intervals in primary care using EMRs.

Methods

Systematic Identification and Assessment of Supporting Evidence

We followed the principles of systematic reviews [7] and developed a protocol a priori to guide the identification and assessment of the monitoring indicators.

Inclusion Criteria

We included clinical guidelines and primary peer-reviewed studies of any design, carried-out mainly in primary care (ie, family health care) patients aged 18 years and older, who were diagnosed with type 2 (non-insulin-dependent) diabetes mellitus, arterial hypertension, asthma, chronic heart failure, or osteoarthritis. The first four diseases are among the most common noninfectious diseases worldwide. Osteoarthritis, in particular, generates a large part of indirect costs [2]. In order to be included, studies must have also reported on indicators that allow the assessment of care and help monitor the status and process of disease for these five chronic conditions. Therefore, we considered disease indicators that help reduce the risk of exacerbation, such as intermediate outcome indicators (eg, hemoglobin A_{1c} [HbA_{1c}] for diabetics or blood pressure measurements for hypertensive patients) and process indicators (eg, regular foot care or nutrition counselling). We included studies regardless of whether specific interventions were evaluated. In addition, all studies and clinical guidelines should have been published in English or German.

Search Methods and Study Identification

We developed a comprehensive search strategy in collaboration with an expert librarian. The librarian conducted the search and produced a set of studies that matched the predefined search criteria. We identified studies published between 2000 and 2015 by applying this strategy in MEDLINE (Ovid), Embase (Elsevier), and the Cochrane Library (Wiley). No restrictions were made regarding the country of origin of the studies. The search strategy included a combination of the concepts and terminology, synonyms and related words for monitoring and for medical, health, electronic, patient, or file records. It also included primary, family, health care, or general practitioner, and the five chronic conditions (ie, type 2 [non-insulin-dependent] diabetes mellitus, arterial hypertension, asthma, chronic heart failure, and osteoarthritis). The focused search also included the terminology indicators, parameter, and management. An example of the full search strategy is available in Multimedia Appendix 1.

We identified additional publications by manually searching the reference lists of included studies and relevant reviews. We also searched for monitoring indicators in the clinical guidelines in order to identify as many indicators as possible and to enable a holistic management of chronic diseases. Given that most guidelines are not indexed in the former medical literature databases, and to identify the clinical guidelines related to any of the five chronic diseases, we searched World Wide Web-based databases, including the National Guideline Clearinghouse for US guidelines [8] and the Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften eV (AWMF) [9] for German guidelines.

Study Selection and Assessment

For study selection, we created a system to prioritize the studies. One reviewer identified eligible studies by first screening the titles and abstracts of all records retrieved by the searches based on the inclusion criteria. All potentially eligible abstracts were rated manually from one to five stars according to their relevance for this review. The stars were assigned based on whether or not the key terms were mentioned (ie, “indicator,” “monitoring,” “assessment,” “management,” and/or “guideline”). The ranking was assigned as follows:

1. One star: Remote reference to the key terms; no indicators expected in full text.
2. Two stars: Little reference to the key terms; indicators in full text unlikely.
3. Three stars: Reference of at least one key term; indicators in full text possible.
4. Four stars: Reference of at least one key term; indicators in full text very possible.
5. Five stars: Reference of indicators, monitoring, or interval of measuring indicators.

The full text of all studies with an abstract that was rated with at least two stars was obtained, if available, and further evaluated based on the reporting of indicators. For studies where the full text was not available but were deemed important to inform our

monitoring tool, we used the data reported in the abstract. When it was necessary, the study team was consulted throughout the evaluation process to confirm the eligibility of indicators.

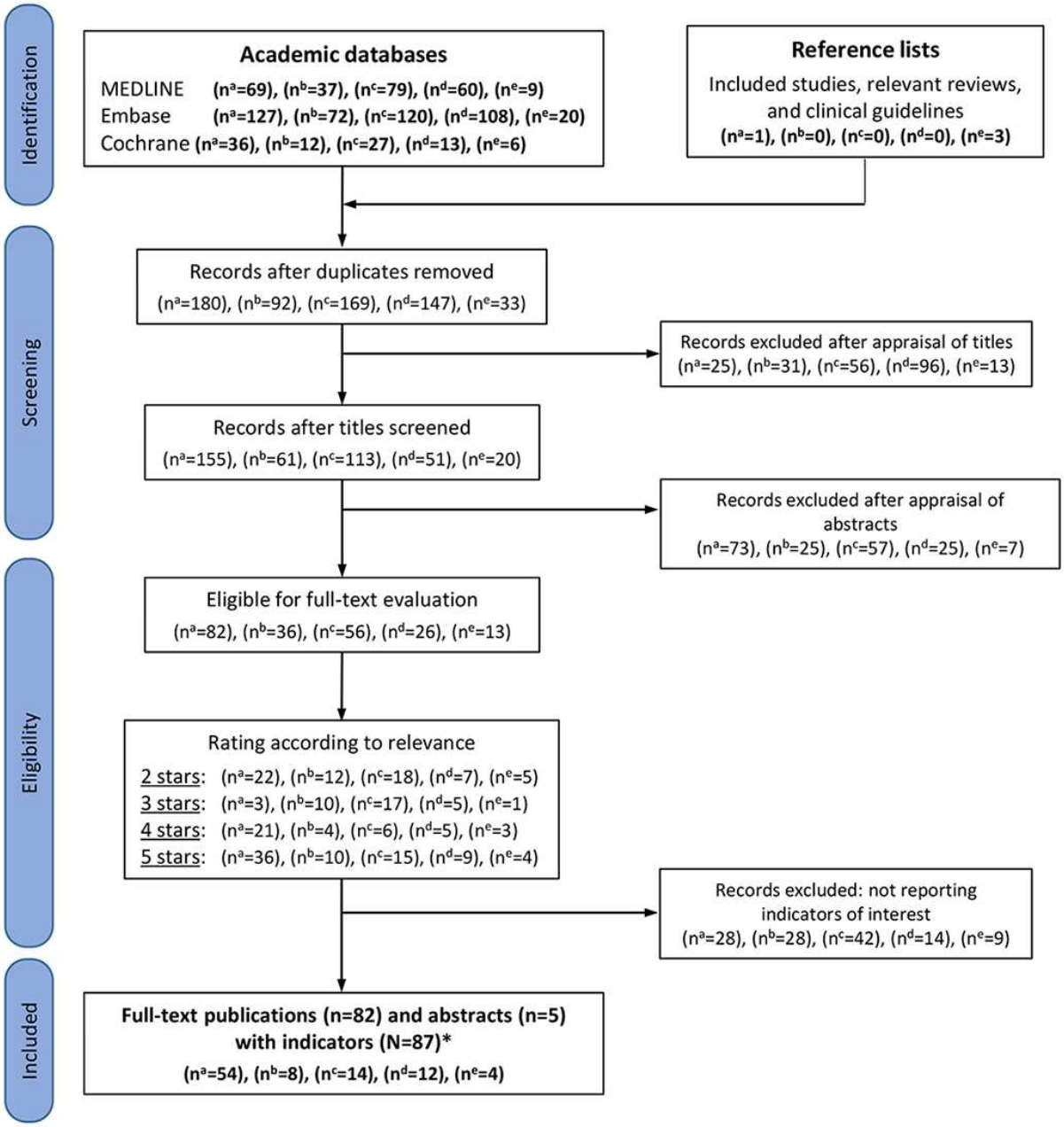
Data Extraction and Synthesis

For each included study, we extracted the bibliographic details (ie, author, year, and country of origin), all the monitoring indicators reported, the guideline on which the indicators were based, and the country of origin of the guidelines for each of the five chronic diseases. One reviewer extracted all data, and another reviewer verified the extracted data. We compiled a data profile for each study or guideline, and generated a set of indicators using Microsoft Excel. We report a descriptive summary of the indicators for each of the chronic conditions.

Results

Our literature searches identified 795 original records (see Figure 1). After deduplication and perusal of titles and abstracts, we screened 621 records (range by disease: 33-180) and excluded 408 records that did not meet our inclusion criteria (eg, focused on specific therapy or medication or did not cover the topic). We examined in detail the full text, where available, of 213 publications (range by disease: 13 to 82).

Figure 1. Flowchart demonstrating the identification and selection of evidence. a: type 2 diabetes mellitus; b: asthma; c: arterial hypertension; d: heart failure; e: osteoarthritis; *: 5 of 87 publications (6%) reported indicators for more than one disease of interest.



We included 87 original publications, 5 (6%) in abstract form only, reporting indicators for diabetes mellitus [10-63], asthma [60,64-70], arterial hypertension [10,35,39,71-81], heart failure [33,82-92], and osteoarthritis [93-96]. Multimedia Appendix 2 presents a list of all included studies that reported monitoring indicators for the five chronic conditions. A total of 5 publications (6%) reported indicators for more than one chronic disease [10,33,35,39,60]. The number of included publications by disease with at least one indicator ranged from 4 to 54. Most records (54/87, 62%) were published on type 2 diabetes mellitus, while osteoarthritis was the most underrepresented of the five diseases, with only 4 records (5%). A total of 74 of all 87 included studies (85%) contained process indicators, the most significant type of indicators. Concerning diabetes mellitus, a third of all publications (54/179, 30.2%) reported at least one indicator. For arterial hypertension and heart failure, only 8% (7/87) of all publications reported at least one indicator. Overall, most records used guidelines from the United States, followed by the United Kingdom. For diabetes mellitus, the American Diabetes Association and the National Institute for Health and Care Excellence were the most-used guidelines. The most frequently mentioned indicators for diabetes are presented in Table 1. The indicators for the other four diseases are presented in Multimedia Appendices 3-6.

Table 1. Diabetes mellitus indicators that are most frequently mentioned in guidelines and studies. The indicators are sorted first by guidelines and then by studies.

Indicators for diabetes mellitus	Number of guidelines where indicators are mentioned (guidelines)	Number of studies where indicators are mentioned
Fundoscopic examination	7 (a-g)[a]	20 [10,12,13,18,21,23,25,30-32,41,43-46,50-52,60,61]
Height, weight, and body mass index	7 (a-g)	33 [11-16,18,20,21,23-25,27-29,32,33,35,40,41,44,45,48,49,53-56,58-60,62,63]
Blood pressure measurement	7 (a-g)	45 [11,13,15-27,29-36,39-45,47-49,52,53,55,56,58-63]
10 g monofilament	7 (a-g)	N/A[b]
Hemoglobin A_{1c} (ie, glycated hemoglobin)	7 (a-g)	46 [10,12,13,15-23,26,28-37,39-45,47-54,56-63]
Foot inspection	7 (a-g)	17 [12,15,18,21,23,25,30-32,43-46,50-52,61]
Erectile dysfunction	7 (a-g)	N/A
Albuminuria	7 (a-g)	18 [12,13,18,22,23,25,31,32,35,41,43-46,51,55,61,62]
Lipid profile	7 (a-g)	8 [25,26,30,43,45,46,52,61]
Low-density lipoprotein	N/A	30 [11,12,15,18-20,22-24,29,31-37,41-44,47-49,52-54,63]
High-density lipoprotein	N/A	14 [11,20,23,28,29,33,37,39,49,51,53,54,62,63]
Triglyceride	N/A	15 [20,29,30,33,37,39,48,49,51,53-55,57,62,63]
Creatinine	7 (a-g)	18 [13,15,16,22,25-27,29,33,41,46,51,55,57-60,62]
Alcohol intake	7 (a-g)	2 [24,53]
Neuropathy and history of foot lesion	7 (a-g)	3 [18,20,55]
History of myocardial infarction (ie, cardiovascular disease)	6 (a-f)	2 [18,22]
Foot pulses	6 (a-f)	3 [18,32,60]
Smoking status	6 (a-f)	24 [11-15,18,20,22-24,26,28,29,31,35,41,44,48,50,53,58-61]
Orthostatic hypotension	5 (a, b, d, e, g)	N/A
Skin inspection	5 (a, b, d, f, g)	N/A
Vibration by 128 Hz tuning fork	5 (a-d, g)	1 [60]
Plasma glucosis	4 (b-d, g)	12 [11,21,24,33,39,45,51,54,55,57,59,63]
Onset of diabetes	3 (b, c, f)	9 [11,18,22,23,28,48,55,58,59]
Indicators appeared in fewer than five guidelines	225	N/A
Indicators appeared in fewer than 10 studies	N/A	76

[a]The letters a-g refer to the guidelines listed in Multimedia Appendices 7-11.

[b]N/A: not applicable.

In total, there were 249 indicators for type 2 diabetes mellitus, 183 for asthma, 335 for arterial hypertension, 231 for chronic heart failure, and 164 for osteoarthritis. The majority of indicators were identified by screening both peer-reviewed articles and clinical guidelines. A few extra indicators were reported only in peer-reviewed articles. That is, clinical guidelines on their own contributed to the great majority of all indicators identified. Surprisingly, only a few guidelines, such as the American guideline for asthma, included a section dedicated to monitoring or follow-up. Most of the guidelines that we screened did not specify the interval at which the indicators should be monitored. Also, in some guidelines, self-monitoring was a big topic for chronic heart disease (ie, weight control), asthma (ie, peak expiratory flow), and type 2 diabetes mellitus (ie, glucose monitoring).

Our systematic review also found that the term "monitoring," in the sense of long-term patient care, was not widely used. Although publications reported the actual monitoring indicators, the process of monitoring for the different diseases, including, for example, the potential risks associated with overmonitoring, was only scarcely addressed. The publication by Glasziou was the only one giving a broader overview on the topic [97]. Only a handful of publications reported a complete set of indicators that can be used for monitoring, but these were either not specific for primary care or not eligible for implementation in EMRs [98-101].

Discussion

Principal Findings

To our knowledge, this study represents the first summary of the existing scientific evidence about the indicators that help standardize the monitoring of chronically ill patients in primary care by the use of EMRs. Long-term care of patients with chronic diseases is challenging and there are deficits regarding their monitoring and structured follow-up. Chronic care often involves collaboration between several people involved in the treatment process. That is only one reason for its complexity. Interpersonal differences in monitoring can decrease the quality of monitoring processes. Surprisingly, there are currently no gold standards or consensus regarding the systematic monitoring of patients with chronic diseases, in particular by means of EMRs. To efficiently monitor patients with chronic diseases, a well-structured and organized EMR system is crucial to ensure that all necessary information can be easily entered and retrieved and that no essential information is missed. Our study is, thus, the first initiative toward the urgent need of standardization for monitoring patients with chronic diseases in primary care.

Our systematic literature review showed that the term "monitoring" in terms of disease management and long-term patient care is not widely used. There is a plethora of literature about quality indicators that might have the potential to improve the outcome of a disease. The Quality and Outcomes Framework (QOF) in the United Kingdom, for example, assesses indicators for such purposes [102]. Beyond identifying indicators that can be easily assessed, such as the indicators used by the QOF, our goal was to summarize the existing literature on all the indicators available for long-term monitoring.

So far, only a few authors have focused on the topic of the monitoring of chronic diseases. According to Glasziou, the process of monitoring aims to establish the response to treatment and to detect both adverse effects and the need to adjust treatment [97]. The process of monitoring can be divided into different phases (ie, pretreatment, during treatment, and after treatment). Each phase requires measurements at different intervals.

When analyzing different diseases, monitoring is probably most widely mentioned in blood pressure management. There are various publications reporting on the optimal way and interval of measuring blood pressure [76,103,104]. However, literature beyond the indicator of blood pressure measurement remains scarce. Regarding diabetes mellitus, there is an extended monitoring tool that was designed as a disease management tool for practice nurses [101]. The tool's design is based on a traffic light scheme to detect any deficit and need for action. In addition, a detailed guideline on how to monitor the diabetic foot is provided by the International Working Group on the Diabetic Foot [105]. As for bronchial asthma, two study groups have addressed the optimal way and potential problems of finding and evaluating indicators to monitor patients with asthma, including an overview of the most important indicators [98,100]. Similarly, Grypdonck presents a small set of indicators for monitoring patients with osteoarthritis of the knee [93]. Self-monitoring seems to be an important topic concerning osteoarthritis and asthma. An English study conducted by interviewing general practitioners about osteoarthritis showed that the majority of respondents thought monitoring of osteoarthritis is important, even though almost half did not monitor patients at all. Interestingly, more than half of the respondents felt that patients should do self-monitoring [106]. Patient involvement is crucial for monitoring. Particularly, in high-frequency monitoring situations such as chronic heart failure, telecardiological service, including transtelephonic monitoring, reduces the length of hospitalization and improves quality of life [91]. Surprisingly, publications concerning monitoring of chronic heart failure seem to be scarce [90]. The underrepresentation of osteoarthritis and chronic heart failure is also reflected in the number of indicators detected in the primary literature, compared to a large number of records reporting on indicators for type 2 diabetes mellitus. Another topic repeatedly found in the results was the involvement of a clinical practice nurse in monitoring [101,107-109]. The clinical nurse can, for example, fill out a monitoring questionnaire in face-to-face sessions with the patient, on the phone, or even electronically. This could counteract the problem of workload and time constraints as a frequent response to why monitoring is not conducted [106].

Strengths and Limitations

To our knowledge, this study represents the first scientifically founded recommendation for the standardized long-term monitoring of chronically ill patients in primary care. Usually, systematic reviews only concentrate on primary literature and do not include guidelines in their search strategy, since most guidelines are not indexed in databases. In our study, we explicitly searched for guideline programs such as the National Guideline Clearinghouse for American guidelines and the

AWMF for German guidelines. We added a substantial number of manual searches within reference lists and search engines in order to gain a maximal insight of the existing literature. This strategy was worth the extra effort, considering that most relevant indicators were found in guidelines and not in the primary literature. Possible confounders are that publications and guidelines reported in languages other than German and English were excluded.

Outlook

In a second step, our extensive set of indicators obtained from this work will serve as a generic template for a monitoring tool. By means of an adapted Delphi procedure, the indicators will be further evaluated in terms of their usability. In a third step, the indicators will be summarized into a user-friendly EMR layout.

Conclusion

This is the first study that systematically summarizes the existing scientific evidence about the standardized long-term monitoring of chronic diseases by means of EMRs. It aims to help improve care for patients with chronic diseases in primary care.

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Authors' Contributions

LF was involved in designing the search strategy, performing the systematic screening and review of the literature, and writing of the manuscript. MZ was involved in study design and revised the manuscript. NAMG contributed to the study design and search strategy; NAMG also revised and improved the manuscript. TR supervised the development and methodology of the study and helped improve the final version of the manuscript. CC was involved in the study design, study selection, and prioritization; CC also verified the extracted data, and supervised and revised the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Search strategy for MEDLINE (Ovid), Embase (Elsevier), and the Cochrane Library (Wiley).

[DOCX File, 14KB - medinform_v7i2e10879_app1.docx]

Multimedia Appendix 2

List of all included studies, including monitoring indicators for the five chronic conditions.

[DOCX File, 27KB - medinform_v7i2e10879_app2.docx]

Multimedia Appendix 3

Asthma indicators mentioned in guidelines and studies.

[DOCX File, 15KB - medinform_v7i2e10879_app3.docx]

Multimedia Appendix 4

Arterial hypertension indicators mentioned in guidelines and studies.

[DOCX File, 16KB - medinform_v7i2e10879_app4.docx]

Multimedia Appendix 5

Chronic heart failure indicators most frequently mentioned in guidelines and studies.

[DOCX File, 14KB - medinform_v7i2e10879_app5.docx]

Multimedia Appendix 6

Osteoarthritis indicators most frequently mentioned in guidelines and studies.

[DOCX File, 14KB - medinform_v7i2e10879_app6.docx]

Multimedia Appendix 7

Guidelines screened for indicators for type 2 diabetes mellitus.

[DOCX File, 14KB - medinform_v7i2e10879_app7.docx]

Multimedia Appendix 8

Guidelines screened for indicators for asthma.

[DOCX File, 13KB - medinform_v7i2e10879_app8.docx]

Multimedia Appendix 9

Guidelines screened for indicators for arterial hypertension.

[DOCX File, 14KB - medinform_v7i2e10879_app9.docx]

Multimedia Appendix 10

Guidelines screened for indicators for chronic heart failure.

[DOCX File, 14KB - medinform_v7i2e10879_app10.docx]

Multimedia Appendix 11

Guidelines screened for indicators for osteoarthritis.

[DOCX File, 13KB - medinform_v7i2e10879_app11.docx]

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Abbreviations

AWMF: Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften eV
CCM: chronic care model
EMR: electronic medical record
HbA_{1c}: hemoglobin A_{1c}
QOF: Quality and Outcomes Framework

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Appendix 1

Search strategy for (OVID) MEDLINE*.

#	Searches	Results
1	(exp Medical Records/ or ((medical or patient) adj3 (record* or file)).ab,ti.) and (general practitioners/ or physicians, family/ or exp Primary Health Care/ or ((general or family or primary) adj3 (doctor* or physician* or practi*)).ab,ti.) and (exp Automatic Data Processing/ or indicator.ab,ti. or managment.ab,ti. or monitoring.ab,ti. or parameter.ab,ti. or ((clinical or laboratory) adj3 (data or assess* or finding* or observ* or monitor* or examin* or check* or control*)).ab,ti. or ((data or information) adj6 (set or extract* or analys* or retriev* or yield* or gather*)).ab,ti. or (data adj6 (standard* or normali* or form*)).ab,ti. or ("data from" adj6 (file or record)).ab,ti.)	2088
2	limit 1 to (yr="2000 -Current" and (english or german))	1593
3	exp Diabetes Mellitus, Type 2/	91561
4	2 and 3	74
5	(self monitoring or (monitoring adj3 glucose)).ab,ti.	9074
6	4 not 5	69
7	exp Hypertension/	215840
8	2 and 7	79
9	exp Heart Failure/	91040
10	2 and 9	22
11	exp heart failure/ or exp myocardial ischemia/	442513
12	2 and 11	60
13	12 not 10	38
14	exp Asthma/	108981
15	2 and 14	37
16	exp Arthritis/	209132
17	2 and 16	16

*Similar search strategies were applied in Embase and Cochrane.

Appendix 2

List of all included studies including monitoring indicators for the five chronic conditions.

First author	Year of publication	Country of origin	Guideline used in the publication	Country of origin of guideline	Reference number
Diabetes mellitus					
Suija	2015	Estonia	Organisation for Economic Co-operation and Development (OECD), American Diabetes Association (ADA), World Health Organization WHO, European Society of Cardiology (ESC), National Institute for Health and Care Excellence (NICE)	various	[10]
Shah	2015	United Kingdom	unknown		[11]
Devkota	2015	USA	American Diabetes Association (ADA)	USA	[12]
Barkhuysen	2014	Netherlands	Dutch College of General Practitioners	Netherlands	[13]
Szczech	2014	USA	Kidney Disease Outcomes Quality Initiative (KDOQI)	USA	[14]
van Melle	2014	Netherlands	Dutch College of General Practitioners	Netherlands	[15]
Djalali	2014	Switzerland	Quality and Outcomes Framework indicator (QOF)	United Kingdom	[16]
Goff	2014	USA	unknown		[17]
Vidal-Pardo	2013	Spain	"Plan de Saude" (Health plan of Galicia)	Spain	[18]
Sidorenkov	2013	Netherlands	Quality and Outcomes Framework indicator (QOF), Dutch College of General Practitioners	United Kingdom, Netherlands	[19]
Winkley	2013	United Kingdom	unknown		[20]

Gavran	2012	Bosnia/Herzegovina	The Committee for Practice Guidelines (CPG)	Europe	[21]
Knudsen	2012	Denmark	Danish National guidelines	Denmark	[22]
Mata-Cases	2012	Spain	RedGDPS (Spain)	Spain	[23]
Nouwens	2012	Netherlands	Dutch College of Family Physicians	Netherlands	[24]
Satman	2012	Turkey	Standard Diabetes Management Procedures of Turkey	Turkey	[25]
Marley	2012	Australia	unknown		[26]
Patapas	2012	Canada	unknown		[27]
Staff	2012	Asutralia	United Kingdom Prospective Diabetes Study	United Kingdom	[28]
Hill	2012	Ireland	indicators selected by authors		[29]
Alfadda	2011	Saudi Arabia	American Diabetes Association (ADA)	USA	[30]
Dickerson	2011	USA	Diabetes Recognition Program (DRP) by the National Committee for Quality Assurance (NCQA)	USA	[31]
Vidal Pardo	2011	Spain	"Plan de Saude" (Health plan of Galicia)	Spain	[32]
Weenink	2011	Netherlands	unknown		[33]
Gladstone	2011	USA	Canadian Practice Guidelines	Canada	[34]
Holbrook	2011	Canada	unspecific cardiovascular risk factors		[35]
O'Connor	2011	USA	unknown		[36]
Sundquist	2011	SWE	Swedish National Guidelines	Sweden	[37]
Reddy	2010	Australia	Quality and Outcomes Framework indicator (QOF)	United Kingdom	[38]
Samoutis	2010	Cyprus	American Diabetes Association (ADA), St. Vincent Declaration	USA, Europe	[39]

Shah	2010	Canada	Canadian Diabetes Association	Canada	[40]
Petrazzuoli	2010	Italy	Quality and Outcomes Framework indicator (QOF)	United Kingdom	[41]
Sperl-Hillen	2010	USA	American Diabetes Association (ADA)	USA	[42]
Pedersen	2009	Greenland	Danish National Indicator Project	Denmark	[43]
Holbrook	2009	Canada	Canadian Diabetes Association and American Diabetes Association (ADA)	Canada, USA	[44]
Moharram	2008	Saudi Arabia	Canadian Diabetes Association	Canada	[45]
Novo	2008	Bosnia/Herzegovina	Canadian Diabetes Association	Canada	[46]
Samuels	2008	USA	American Diabetes Association (ADA)	USA	[47]
Smith	2008	USA	American Diabetes Association (ADA), National Committee for quality assurance	USA	[48]
Voorham	2008	NL	National Guidelines of Netherlands	Netherlands	[49]
Wens	2007	Belgium	various guidelines	Belgium, Netherlands, Germany, United Kingdom, France	[50]
Nitiyanant	2007	Thailand	unknown		[51]
Herrin	2006	USA	National Diabetes Quality Improvement Alliance guidelines	USA	[52]
Wan	2006	Australia	Australian guidelines for diabetes management in general practice, National	Australia, United Kingdom	[53]

			Institute for Health and Care Excellence (NICE)		
Al Khaja	2005	Bahrain	The Seventh Report of the Joint National Committee (JNC-7)	USA	[54]
Cueto-Manzano	2005	Mexico	unknown		[55]
Lusignan	2005	United Kingdom	National Institute for Health and Care Excellence (NICE)	United Kingdom	[56]
Sequeira	2004	Bahrain	The Sixth Report of the Joint National Committee (JNC-6)/International Society of Hypertension (ISH)	USA, international	[57]
Wermeille	2004	Switzerland	unknown		[58]
Goudswaard	2003	Netherlands	Dutch College of General Practitioners	Netherlands	[59]
Campbell	2002	United Kingdom	Developed within study		[60]
Parchman	2002	USA	American Diabetes Association (ADA)	USA	[61]
Renders	2001	Netherlands	Dutch College of General Practitioners	Denmark	[62]
Linmans	2001	Netherlands	unknown		[63]
Asthma					
Minard	2014	Canada	Asthma Care Map	Canada	[64]
Lim	2012	USA	National Assessment of Educational Progress (NAEP)	USA	[65]
Lougheed	2012	Canada	Canadian Asthma Consensus Guidelines/Canadian Thoracic Society	Canada	[66]
Oei	2011	Australia	unknown		[67]
Nokela	2010	Sweden	unknown		[68]
Yawn	2008	USA	APGAR tool/ National Heart, Lung, and Blood Institute (NHLBI)	USA	[69]

Baddar	2006	Oman	Oman's national Manual for the Management of Asthma in Adults	Oman	[70]
Campbell	2002	United Kingdom	indicators selected by authors		[60]
Arterial hypertension					
Suija	2015	Estonia	Organisation for Economic Co-operation and Development (OECD), European Society of Cardiology (ESC), World Health Organization (WHO)/ International Society of Hypertension (ISH)	internationa l, Europe	[10]
Hasselstrom	2014	Sweden	unknown		[71]
Tong	2012	Malaysia	Clinical Practice Guideline for Hypertension in Malaysia	Malaysia	[72]
Holbrook	2011	Canada	unknown		[35]
Samoutis	2010	Cyprus	Report of the Joint National Committee (JNC), the European guidelines on cardiovascular disease prevention and the European Society of Hypertension, European Society of Cardiology Guidelines.	USA, Europe	[39]
Pavlik	2009	USA	The Seventh Report of the Joint National Committee (JNC-7)	USA	[73]
Chan	2006	China	Eli Lilly National clinic audit center, Report of the Joint National Committee (JNC)	United Kingdom, USA	[74]
Asnani	2005	Jamaica	Ministry of Health	Jamaica	[75]
Rabinowitz	2005	Israel	American Heart Association	USA	[76]

			(AHA)/American College of Cardiology (ACC), National Cholesterol Education Program		
Mitchell	2005	United Kingdom	unknown		[77]
Alli	2005	Italy	unknown		[78]
Tierney	2004	USA	unknown		[79]
Lackland	2004	USA	The Seventh Report of the Joint National Committee (JNC-7)	USA	[80]
Frijling	2003	Netherlands	Dutch college of General Practitioners	Netherlands	[81]
Heart failure					
Amarasingham	2013	USA	unknown		[82]
Logeart	2013	France	European Society of Cardiology (ESC)	Europe	[83]
Weenink	2011	Netherlands	unknown		[33]
Lind	2011	Sweden	unknown		[84]
Korb	2010	Germany	Deutsche Gesellschaft für Allgemeinmedizin und Familienmedizin (DEGAM)-Leitlinie	Germany	[86]
Maddocks	2010	Canada	Heart failure management incentive (ministry of health and long-term care)	Canada	[85]
Fonarow	2010	USA	American College of Cardiology/American Heart Association	USA	[87]
Vercauteren	2009	Belgium	unknown		[88]
Majeed	2005	United kingdom	Quality and Outcomes Framework indicator (QOF)	United Kingdom	[89]
Roth	2004	Israel	unknown		[91]
Subramanian	2004	USA	Kansas City Cardiomyopathy Questionnaire	USA	[90]

Gnani	2004	United Kingdom	Quality and Outcomes Framework indicator (QOF)	United Kingdom	[92]
Osteoarthritis					
Grypdonck	2014	Belgium	indicators selected by authors		[93]
Jansen	2010	Netherlands	Osteoarthritis of the hip and knee for physical therapist	Netherlands	[94]
MacLean	2004	USA	indicators selected by authors		[95]
Peat	2002	United Kingdom	indicators selected by authors		[96]

Appendix 3

Asthma indicators mentioned in guidelines and studies. The indicators are sorted first by guidelines and then by studies.

indicators for asthma	appeared in guidelines	appeared in studies
Fev_1/FVC Ratio	**6** (a-f)	-
lung function	**6** (a-f)	**3** [64, 66, 69]
Daytime asthma symptoms	**6** (a-f)	**4** [60, 64, 66, 69]
Any night waking due to asthma	**5** (a, c-f)	**5** [60, 64, 66, 68, 69]
Any activity limitation due to asthma	**5** (a, c-f)	**4** [60, 64, 66, 69]
FEV_1	**5** (a-c, e, f)	**1** [68]
PEF (self-monitoring)	**5** (a-c, e, f	**4** [60, 64, 68, 70]
wheezing	**4** (b-e)	**2** [64, 69]
cough	**4** (b-e)	**2** [64, 69]
Reliever needed for symptoms more than twice per week	**4** (a, c, d, f)	**2** [64, 68]
smoking habit	**4** (a-d)	**3** [60, 65, 68]
auscultation	**4** (a, b, d, e)	-
bronchial provocation test	**4** (a, b, d, e)	-
variation in lung function	**4** (a, d-f)	-
check inhaler technique	**3** (a-c)	**4** [60, 64, 69, 70]
trigger of symptoms	**3** (a, c, d)	**3** [64, 69, 70]
hospital stays or emergency department visits since last visit	**1** (c)	**3** [64, 66, 70]
medication history	**2** (a,c)	**3** [64, 69, 70]
smoking cessation advice	-	**3** [60, 64, 66]
check adherence	**2** (a,c)	**3** [64, 68, 70]
asthma action plan	-	**3** [64, 66, 69]
indicators appeared in less than 4 guidelines	**162**	

indicators appeared in less than 3 studies		**38**

Letters a-f refers to the guidelines listed in Appendix 8; FEV_1/FVC Ratio: Tiffeneau-Pinelli index.
FEV_1: Forced expiratory volume at one second. PEF: peak expiratory flow.

Appendix 4

Arterial hypertension indicators mentioned in guidelines and studies. The indicators are sorted first by guidelines and then by studies.

indicators for arterial hypertension	appeared in guidelines	appeared in studies
smoking habit	**8** (a-h)	**11** [35, 71-79, 81]
blood pressure	**8** (a-h)	**9** [10, 35, 39, 71-73, 75, 77-79]
choose correct cuff	**8** (a-h)	**1** [75]
standing blood pressure	**8** (a-h)	-
electrocardiogramm	**8** (a-h)	**2** [72, 75]
fasting blood glucose and or HbA1c	**8** (a-h)	**6** [39, 71, 72, 75, 79, 80]
serum totalcholesterine	**8** (a-h)	**8** [10, 39, 71, 72, 74, 75, 79, 80]
high density lipoprotein	**8** (a-h)	**5** [39, 71, 72, 76, 80]
creatinine	**8** (a-h)	**4** [71, 75, 79, 80]
potassium	**8** (a-h)	**3** [75, 79, 80]
age	**7** (a-f, h)	**2** [76, 78]
history of chronic kidney disease	**7** (a, c-h)	**2** [78, 79]
recreational drug use	**7** (a, c-h)	-
current medication	**7** (a, c-h)	**3** [73, 75-77]
family history	**7** (a-d, g, h)	**3** [72, 74, 76]
family history for coronary heart disease	**7** (a-d, g, h)	**3** [72, 74, 76]
BMI/weight	**7** (a-f, h)	**8** [35, 71, 72, 74-76, 78, 79]
resting comfortably for several minutes prior to blood pressure measurement	**7** (a, b, d-h)	-
measure blood pressure on both arms	**7** (a-e, g,h)	-
Home blood pressure monitoring or ambulatory blood pressure monitoring if suspected white coat hypertension	**7** (a-g)	-
eye examination	**7** (a-d, e-h)	3 [72, 74, 75]
echocardiography if needed	**7** (a-c, e-h)	-

low density lipoprotein	**7** (a, b, d-h)	**6** [35, 39, 71, 72, 76, 80]
triglycerides	**7** (a, b, d-h)	**6** [39, 71, 72, 75, 76, 80]
Assessment of microalbuminuria	**7** (a, b, d-h)	**4** [71, 72, 79, 80]
sedentary lifestyle	**6** (a, d-h)	**5** [35, 74-76, 78]
diabetes mellitus in history	**6** (a, c, d, f-h)	**6** [72, 74, 76-79]
alcohol	**3** (e, g, h)	**4** [74, 75, 78, 79]
history of coronary heart disease/cardiovascular disease/stroke	**5** (a, d-g)	**2** [77-79]
indicators appeared in less than 7 guidelines	**307**	
indicators appeared in less than 3 studies		**58**

Letters a-h refer to the guidelines listed in Appendix 9; BMI: body mass index.

Appendix 5

Chronic heart failure indicators most frequently mentioned in guidelines and studies. The indicators are sorted first by guidelines and then by studies.

indicators for chronic heart failure	appeared in guidelines	appeared in studies
sodium	**6** (a-f)	**4** [33, 85, 87, 89]
potassium	**6** (a-f)	**3** [33, 85, 89]
creatinine	**6** (a-f)	**5** [33, 82, 83, 85, 87]
daily weight measurement	**5** (a, b, d-f)	**3** [84, 88, 91]
changes in weight	**5** (a, b, d-f)	
depression	**5** (a, c-f)	-
address palliative or hospice care	**5** (a, c, d-e)	-
NYHA-classification	**5** (a, c-f)	**2** [87, 90]
pulse rate	**5** (a-c, e-f)	**3** [83, 85, 87]
exercise capacity	**5** (a, b, d-f)	**2** [86, 90]
erectile dysfuntion/sexual activity	**4** (a, d, e, f)	-
measure blood pressure	**4** (a, b, d, e)	**5** [33, 85, 87, 89, 92]
measure daily blood pressure		**3** [84, 88, 91]
electrocardiography	**4** (a, d-f)	**4** [85, 86, 89, 92]
echocardiogram with doppler	**4** (a, d-f)	**6** [85-89, 92]
NT-proBNP	**3** (d-f)	**5** [82, 83, 86-88]
chest radiography if necessary	**3** (d-f)	**4** [85, 86, 89, 92]
BMI	**2** (e, f)	**3** [33, 85, 89]
history/signs of diabetes mellitus	**3** (a, d, f)	**3** [82, 87, 89]
number of indicators that appeared in less than 4 guidelines	**213**	
number of indicators that appeared in less than 3 studies		**47**

Letters a-f refer to the guidelines listed in Appendix 10; NT-proBNP: N-terminal prohormone Brain natriuretic peptide. BMI: body mass index.

Appendix 6

Osteoarthritis indicators most frequently mentioned in guidelines and studies. The indicators are sorted first by guidelines and then by studies.

indicators for osteoarthritis	appeared in guidelines	appeared in studies
tenderness	**4** (a-d)	
significant loss of range of movement	**4** (a-d)	
assessment of functional status		**2** [94, 95]
mood	**3** (a-c)	
health believes	**3** (a-c)	
expectations, concerns, ideas	**3** (a-c)	
stiffness	**3** (a, c, d)	
stress pain	**3** (a, c, d)	
activity of daily living	**3** (a, b, d)	
Hobbies	**3** (a-c)	
history of trauma	**3** (a, c, d)	
swelling	**3** (a, c, d)	
redness	**3** (a-c)	
deformity	**3** (a, b, d)	
advise on losing and maintaining weight		**2** [93, 95]
assessment of pain		**2** [94, 95]
number of indicators that appeared in less than 3 guidelines	**148**	
number of indicators that appeared in only one study		**38**

Letters a-f refer to the guidelines listed in Appendix 11.

Appendix 7

Guidelines screened for indicators for diabetes mellitus type2.

Diabetes mellitus	Year (last update)	editor/publisher	country	
Standards of Medical Care in Diabetes	2014	American Diabetes Association (ADA)	USA	a
Nationale VersorgungsLeitlinien	2013, 2015	Bundesärztekammer (BÄK), Kassenärztliche Bundesvereinigung (KBV), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF) (AWMF Institute for Medical Knowledge Management)	Germany	b
National Institute for Health and Care Excellence (NICE)	2014	Royal College of Physicians	England	c
Global Guideline for Type 2 Diabetes	2012	International Diabetes Federation	International	d
General practice management of type 2 diabetes	2014	The Royal Australian College of General Practitioners	Australa	e
Clinical Practice Guidelines	2013	Canadian Diabetes Association	Canada	f
MediX-Guideline zu Diabetes mellitus	2013	MediX	Schweiz	g

Appendix 8

Guidelines screened for indicators for asthma.

Asthma	**Year (last update)**	**editor/publisher**	**country**	
Global strategy for Asthma Management and Prevention	2015	Global Initiative for Asthma (GINA)	international	a
Asthma: diagnosis and monitoring of asthma in adults, children and young people	Draft for Consultation 2015	National Institute for Health and Care Excellence (NICE)	England	b
Guidelines for the Diagnosis and Management of Asthma	2007	National Heart, Lung, and Blood Institute (NHBLI)	USA	c
Australian Asthma Handbook (Quick Reference Guide)	2014	The Royal Australian College of General Practitioners	Australia	d
Leitlinien zu Diagnostik und Therapie von Patienten mit Asthma	2006	Deutsche Atemwegsliga, Deutsche Gesellschaft für Pneumologie und Beatmungsmedizin e.V.	Germany	e
MediX-Guideline zu Asthma bronchiale	2011	MediX	Switzerland	f

Appendix 9

Guidelines screened for indicators for arterial hypertension.

Arterial hypertension	**Year (last update)**	**editor/publisher**	**country**	
Leitlinien für das Management der arteriellen Hypertonie (Guidelines for management of arterial hypertension)	2013	Deutsche Gesellschaft für Kardiologie-, Herz- und Kreislaufforschung (DGK) (German Cardiac Society) and Deutsche Hochdruckliga e.V. DHL® Deutsche Gesellschaft für Hypertonie und Prävention	Germany	a
Practice Guidelines for the Management of Arterial Hypertension	2007	The European Society of Cardiology (ESC) and European Society of Hypertension (ESH)	Europe	b
Clinical management of primary hypertension in adults	2013	National Institute for Health and Clinical Excellence (NICE)	England	c
The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure	2003	National Heart, Lung, and Blood Institute (NHLBI)	USA	d
The 2015 Canadian Hypertension Education Program Recommendations	2015	Hypertension Canada	Canada	e
Clinical Practice Guidelines for the Management of Hypertension in the Community	2014	The American Society of Hypertension and the International Society of Hypertension (ISH)	USA, international	f
Guide to management of hypertension 2008 (Assessing and managing raised blood pressure in adults)	2010	National Heart Foundation of Australia	Australia	g

Arterielle Hypertonie Empfehlungen für Ärzte	2015	Swiss Society of Hypertension (Schweizerische Hypertonie Gesellschaft)	Switzerland	h

Appendix 10

Guidelines screened for indicators for chronic heart failure.

Chronic heart failure	**Year (last update)**	**editor/publisher**	**country**	
Nationale VersorgungsLeitlinie	2011	Bundesärztekammer (BÄK), Kassenärztliche Bundesvereinigung (KBV), Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF) (AWMF Institute for Medical Knowledge Management)	Germany	a
Anforderungen an ein Modul „Chronische Herzinsuffizienz“ für strukturierte Behandlungsprogramme für Koronare Herzkrankheit (KHK)	--	Empfehlungen des Gemeinsamen Bundesausschusses gemäss §137f Abs. 2 SGB V für die Rechtsverordnung nach § 266 Abs. 7 SGB V	Germany	b
Chronic Heart Failure; National clinical guideline for diagnosis and management in primary and secondary care	2010	National Institute for Health and Clinical Excellence (NICE)	England	c
ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012	2012	The European Society of Cardiology (ESC)	Europe	d
Guideline for the Management of Heart Failure	2013	The American College of Cardiology Foundation and the American Heart Association	USA	e
Guidelines for the prevention, detection and management of chronic heart failure in Australia	2011	National Heart Foundation of Australia	Australia	f

Appendix 11

Guidelines screened for indicators for osteoarthritis.

Osteoarthritis	**Year (last update)**	**editor/publisher**	**country**	
Osteoarthritis; Care and management in adults	2014	National Institute for Health and Clinical Excellence (NICE)	England	a
EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis	2013	The European League against Rheumatism	Europe	b
Guideline for the non-surgical management of hip and knee osteoarthritis	2009	The Royal Australian College of General Practitioners	Australia	c
MediX-Guideline zu Arthrose	2013	MediX	Schweiz	d